

FOOD OF SOME SHORTGRASS PRAIRIE COLEOPTERA^{1,2,3}

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ABSTRACT: Based on diet analysis of adults of some common shortgrass prairie Coleoptera, it was determined that most species studied were polyphagous, but with strong preferences for specific plant species. The species investigated were Cantharidae: *Chauliognathus scutellaris*, Cerambycidae: *Crossidius discoideus sayi*, *C. pulchellus*, Meloidae: *Epicauta ferruginea*, *E. fortis*, *E. parva*, *E. pennsylvanica*, *E. stuarti*, *Lytta biguttata*, *L. viridana*, *Meloe niger*, *Pyrota engelmanni*, *Zonitis sayi*, Scarabaeidae: *Diplotaxis haydeni*, Tenebrionidae: *Bothrotes plumbeus plumbeus*, *Eusattus convexus* and *Glyptasida sordida*.

The gut contents of some miscellaneous species of beetles were analyzed to determine food preference as part of a program to establish trophic levels for the insect fauna of a shortgrass prairie. This was done in conjunction with a survey of shortgrass prairie insect fauna (Kumar et al. 1976) as part of the U.S. International Biological Program Grassland Biome Project.

The study site was located in pastures on the USDA Agricultural Research Service Central Plains Experimental Range in northeastern Colorado. This area, commonly called the "Pawnee Site," is a field research facility of the Natural Resource Ecology Laboratory, Colorado State University and is located approximately seven miles north of Nunn, Colorado (T10N, R66W). Dickinson and Baker (1972) provided a listing of the ca. 300 species of plants on the Pawnee Site available to insects as a food source, of which ca. 100 species are common.

Materials and Methods

Insects to be dissected were collected incidently while other studies were being pursued. Collected specimens were immediately immersed in 70% ethanol. In the laboratory the digestive systems were removed and their contents transferred to microscope slides, utilizing the "micro-techniques" method for grasshopper gut analysis of Mulkern and Anderson

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(1959), Mulkern et al. (1964, 1969). The technique was modified somewhat following the lead of Hansen and Flinders (1969). As these authors indicated, this method "is the most accurate for identifying plant material taken from the stomachs of herbivores," since it compares the characteristics of epidermal plant tissues of known plant species occurring in the habitat with those found in the guts of the plant eaters.

The contents of the insect's digestive tract were mixed with a few drops of Hertwig's solution on the slide surface. The slide was then held over an open flame until it boiled during which the color cleared from the epidermal cells. Several drops of Hoyer's solution were added; the slide was reflamed and a cover glass was placed over the mixture. The slide was allowed to dry in an oven at 65°C for two to three days.

The slides were sent to the Diet Analysis Laboratory at Colorado State University for reading. Twenty fields were examined on each slide and only those fragments recognized as epidermal tissue were recorded for presence of a plant species. The presence of pollen, petals, moss, endogeneous fungi and arthropod fragments was also noted. The data were sent to the Natural Resource Ecology Laboratory for transfer to punch cards for computer analysis.

Percentages and indices were calculated as follows:

Food Plants Ingested — This category was established by the reading, and recorded as percentages of a specific food plant derived from the total number of fields examined. Since the occurrence of more than one plant species in a digestive tract was common, total ingestion could exceed 100%. This probably indicates that the insect did not fill its gut cavity while feeding on one plant, but moved from plant to plant during the feeding process. If a particular plant appeared in the guts of most insect specimens representing a single species, it was assumed that this was the principal acceptable food within the habitat.

Plant Specificity Index — This category was determined (after Mulkern et al., 1969) by multiplying the percent ingestion of the most frequently ingested plant by three, the second most ingested by two and the third by one, summing the quotients and dividing by three. This provided an indication of selectivity with a number approaching 100 indicating that ingestion was restricted to few plant species, while progressively lower figures indicated less restrictive feeding.

Results

Based on field observations of feeding beetles, it is assumed that the plant material ingested by Coleopterous species other than that of the three species of Tenebrionidae was 100 percent live matter. However, once the

material was processed on slides, there was no way to distinguish live material from dead. The percentages recorded for food plants are presented as percent dry weight.

Tenebrionid species have been observed feeding on live plant material, although they are generally regarded as scavengers. On the Pawnee Site, I have observed *Edrotes rotundatus* (Say) feeding on leaves of *Cirsium undulatum*; *Elodes obsoleta* (Say) feeding on petals and stamens of *Chrysothamnus nauseosus*; *E. hispilabris* (Say) feeding on *Bouteloua gracilis*, *Oxytropis sericea* and *Sphaeralcea coccinea* (Kumar et al. 1976); *Bothrotes plumbeus plumbeus* (LeConte) feeding on petals and stamens of *C. nauseosus* and on pollen, petals and developing seeds of *Cirsium undulatum* (Lavigne 1976). As opposed to live material, I have observed *Eleodes hispilabris* feeding on the remains of a black carabid, *Eleodes extricata* (Say) feeding on a dead red legged mite and *Glyptasida sordida* (LeConte) feeding on the tip of a twig lying on the soil.

Most of the Coleopterous species studied are generalists, but with strong preferences for certain plant species. Only *Meloe niger* Kirby and *Glyptasida sordida* (LeConte) had plant specificity indices below 55 suggesting that these two species are true generalists. The latter species may well be more scavenger than herbivore, although it could be picking up live material discarded by sloppy insects, such as grasshoppers and meloids. The high index number (97.2) for *Bothrotes plumbeus plumbeus* (LeConte), and the percent (100) feeding on petals and/or sepals, indicates that this species is a true live plant tissue feeder.

CANTHARIDAE

Chauliognathus scutellaris LeConte: Number analyzed - 172; plant specificity index - 80.3; number with empty digestive tracts - 0; percent feeding on petals and/or sepals - 17; percent feeding on pollen - 1.2. HOSTS - FORBS: *Chrysothamnus nauseosus* - 68.9%, *Grindelia squarrosa* - 4.6%, *Senecio spartioides* - 13.6%; GRASSES: *Aristida longiseta* - 4.6%, *Bouteloua gracilis* - 9.1%.

CERAMBYCIDAE

Crossidius discoideus sayi (Say): Number analyzed - 37; plant specificity index - 74.1; number with empty digestive tracts - 6; percent feeding on petals and/or sepals - 74.2; percent feeding on pollen - 22.6. HOSTS - FORBS: *Artemisia frigida* - 4.3%, *Heterotheca villosa* - 3.2%, *Chrysothamnus nauseosus* - 53.5%, *Cirsium undulatum* - 16.1%, *Gutierrezia sarothrae* - 22.8%, undetermined forb - 0.4%.

Crossidius pulchellus LeConte: Number analyzed - 15; plant specificity index - 90; number with empty digestive tracts - 0; percent feeding on petals and/or sepals - 80; percent feeding on pollen - 20. HOSTS - FORBS: *Artemisia frigida* - 0.8%, *Chrysothamnus nauseosus* - 12.5%, *Grindelia squarrosa* - 4.9%, *Gutierrezia sarothrae* - 80%, undetermined forbs 0.05%; GRASSES: *Bouteloua gracilis* - 1.8%.

MELOIDAE

- Epicauta ferruginea* (Say): Number analyzed - 184; plant specificity index - 83.4; number with empty digestive tracts - 0; percent feeding on petals and/or sepals - 100; HOSTS - FORBS: *Chrysothamnus nauseosus* - 1.1%, *Cirsium undulatum* - 62.7%; *Grindelia squarrosa* - 8.7%, *Gutierrezia sarothrae* - 26.6%, *Helianthus annuus* - 0.1% and *Kochia scoparia* 0.7%.
- Epicauta fortis* Werner: Number analyzed - 35; plant specificity index - 63.9; number with empty digestive tracts - 0; percent feeding on petals and/or sepals - 51; percent feeding on pollen - 0.9. HOSTS - FORBS: *Artemisia frigida* - 14.5%, *Chrysothamnus nauseosus* - 35.5%, *Grindelia squarrosa* - 15%, *Gutierrezia sarothrae* - 35%.
- Epicauta parva* (Haldeman): Number analyzed - 115; plant specificity index - 74.3; number with empty digestive tracts - 3; percent feeding on petals and/or sepals - 59; percent feeding on arthropod parts - 0.4; percent feeding on endogeneous fungi - 0.2; percent feeding on the lichen (*Parmelia chlorochroa*) - 0.3, percent feeding on moss - 0.4. HOSTS - FORBS: *Allium textile* - 0.01%, *Artemisia frigida* - 0.3%, *Atriplex canescens* - 1.9%, *Chrysothamnus nauseosus* - 0.03%, *Descurainia pinnata* - 0.2%, *Erigeron canadensis* - 0.1%, *Erigeron divergens* - 0.3%, *Gutierrezia sarothrae* - 0.9%, *Kochia scoparia* - 3.4%, *Lepidium densiflorum* - 1.8%, *Leucocrinum montanum* - 0.05%, *Oxytropis lambertii* - 5.2%, *Oxytropis sericea* - 50.5%, *Polanisia trachysperma* - 0.2%, *Salsola kali tenuifolia* - 1.3%, *Sophora sericea* - 33.1%, unknown forb - 0.1%; GRASSES: *Bouteloua gracilis* - 0.2%, *Bromus tectorum* - 0.1%, *Volpia octoflora* - 0.5%.
- Epicauta pennsylvanica* (DeGeer): Number analyzed - 115; plant specificity index - 88.8; number with empty digestive tracts - 3; percent feeding on petals and/or sepals - 99.1; percent feeding on pollen - 27.8. HOSTS - FORBS: *Artemisia frigida* - 0.96%; *Chrysothamnus nauseosus* - 4%; *Grindelia squarrosa* - 20%; *Gutierrezia sarothrae* - 74.1%; undetermined forb - 9%. Previously recorded as feeding on pollen of *Gutierrezia sarothrae* by Selander (1954).
- Epicauta stuarti* LeConte: Number analyzed - 210; plant specificity index - 92.2; number with empty digestive tracts - 7; percent feeding on pollen - 2. HOSTS - FORBS: *Chrysothamnus nauseosus* - 14.8%, *Grindelia squarrosa* - 4.3%, *Gutierrezia sarothrae* - 80.8%. Recorded as feeding on pollen of *Gutierrezia sarothrae* by Selander (1954).
- Lytta biguttata* LeConte: Number analyzed - 4; plant specificity index - 100; number of empty digestive tracts - 3. HOST - FORBS: *Oenothera albicaulis* - 100%. Previously recorded as occurring on a variety of Compositae by Selander (1960), including *Haplopappus spinulosus*, *Bahia absinthifolia*, *B. pedata*, *Baileya multiradiata*, *Verbesina encelioides* and *Hymenoxys richardsoni*.
- Lytta viridana* LeConte: Number analyzed - 105; plant specificity index - 88.3; number with empty digestive tracts - 0; percent feeding on petals and/or sepals - 94; percent feeding on pollen - 1.9. HOSTS - FORBS: *Lathyrus polymorphus* - 1.9%, *Oxytropis sericea* - 27.6%, *Penstemon angustifolius* - 0.9%, *Sophora sericea* - 69.2%; GRASSES: *Aristida longiseta* 0.06%, *Bouteloua gracilis* - 0.1%, *Sporobolus cryptandrus* - 0.04%, *Stipa comata* - 0.1%. Previously recorded as feeding on *Astragalus pectinatus* and *A. bisulcatus* by Fox (1943) and on caragana and peavine by Selander (1960).

Meloe niger Kirby: Number analyzed - 54; plant specificity index - 46.1; number with empty digestive tracts - 0; percent feeding on petals and/or sepals - 0; percent feeding on endogeneous fungi - 0.1. HOSTS - FORBS: *Allium textile* - 12.6%, *Aster tanacetifolius* - 0.6%, *Atriplex canescens* - 0.2%, *Cryptantha fendleri* - 2.2%, *Descurainia pinnata* - 14.2%, *Kochia scoparia* - 1.3%, *Lappula redowskii* - 0.1%, *Lepidium densiflorum* - 10.7%, *Salsola kali tenuifolia* - 8.9%, *Sophora sericea* - 32.4%, *Sphaeralcea coccinea* - 1.9%, *Yucca glauca* - 0.2%, undetermined forb - 1.8%; GRASSES: *Bouteloua gracilis* - 1.1%, *Bromus tectorum* - 12.7%; SEDGES: *Carex heliophila* - 0.5%. Previously recorded as on *Allium* sp., *Anemone* sp., *Asparagus officinalis*, *Ranunculus* sp., and *Taraxacum officinale* by Pinto and Selander (1970) and on eight forbs and six grasses by Mayer and Johnsen (1978), none of which are recorded herein.

Pyrota engelmanni LeConte: Number analyzed - 72; plant specificity index - 71.3; number with empty digestive tracts - 6; percent feeding on petals and/or sepals - 95.5; percent feeding on endogeneous fungi - 0.86. HOSTS - FORBS: *Artemisia frigida* - 1.4%, *Chrysothamnus nauseosus* - 0.05%, *Oxytropis lambertii* - 17.3%, *Oxytropis sericea* - 39.2%, *Salsola kali tenuifolia* - 0.8%, *Sophora sericea* - 39.4%. GRASSES: *Bouteloua gracilis* - 0.1%, *Volpia octoflora* - 1.5%.

Zonitis sayi Wickham: Number analyzed - 4; plant specificity index - 100; number with empty digestive tracts - 1; percent feeding on inflorescences - 100; percent feeding on pollen - 100. HOSTS - FORBS: *Grindelia squarrosa* - 100%.

SCARABAEIDAE

Diplotaxis haydeni LeConte: Number analyzed - 14; plant specificity index - 95.2; number with empty digestive tracts - 11. HOSTS - GRASSES: *Aristida longiseta* - 85.6%, *Bouteloua gracilis* - 14.4%.

TENEBRIONIDAE

Bothrotes plumbeus plumbeus (LeConte): Number analyzed - 36; plant specificity index - 97.2; number with empty digestive tracts - 0; percent feeding on petals and/or sepals - 100. HOSTS - FORBS: *Cirsium undulatum* 5-6%, *Chrysothamnus nauseosus* - 93.1%, *Gutierrezia sarothrae* - 1.4%.

Eusattus convexus LeConte: Number analyzed - 14; plant specificity index - 61; number with empty digestive tracts - 0; percent feeding on arthropod parts - 4.6; percent feeding on moss - 0.3. HOSTS - FORBS: *Artemisia frigida* - 9.7%, *Cryptantha fendleri* - 0.05%, *Helianthus annuus* - 9.8%, *Helianthus petiolaris* - 49.2%, *Kochia scoparia* - 0.6%, *Oenothera coronopifolia* - 3.8%, *Oxytropis sericea* - 2%, *Sphaeralcea coccinea* - 12.9%; GRASSES: *Sporobolus cryptandrus* - 7.1%.

Glyptasida sordida (LeConte): Number analyzed - 7; plant specificity index - 54.1; number with empty digestive tracts - 1; percent feeding on petals and/or sepals - 33.3; percent feeding on arthropod parts - 0.2. HOSTS - FORBS: *Artemisia frigida* - 0.1%, *Cryptantha fendleri* 0.05%, *Erigeron* species - 1.1%, *Mirabilis linearis* - 3.3%; *Oenothera coronopifolia* - 1.7%; *Opuntia polyacantha* - 28.4%; *Plantago purshii* - 13.4%; *Psoralea tenuiflora* - 14.1%, *Sophora sericea* - 3.9%, *Sphaeralcea coccinea* - 0.9%, undetermined forbs - 2%; GRASSES: *Bouteloua gracilis* - 30.5%; SEDGES: *Carex heliophila* - 0.1%.

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